Pollution Prevention Opportunities for Petroleum Refining Industry

The keys to pollution prevention for the petroleum refining industry are, for the short term, waste segregation, good operating practices and oil recovery. For the medium term, the driving force is probably product reformulation, which has resulted in production changes in meeting limitations for air toxic compounds and vapor pressure in fuel products. For the longer term, the keys may be more targetted hydrocarbon rebuilding and reforming to produce the desirable fuel components, while avoiding the undesirable toxic ones. More specifically, catalytic conversions and expanded use of hydrogenation may hold the most promise.

Y/N	Opportunities	Comments

(The following checklist presents a compilation of pollution prevention opportunities. However, since every refinery is unique, some of the opportunities may be more applicable to one refinery than to another. Please use the checklist with caution.)

I. Good Operating Practices

Material Input, Storage and Handling

Y/N	Opportunities	Comments
___	Specify lower bottom sludge and water content for crude oil supply	To reduce wastes in storage tank and desalter through improved separation of water and bottom sludge at extraction
___	Use recycled water as make-up water for crude desalter	Recycled water quality is sufficient for desalting
___	Reroute desalter water with emulsifiers to intermediate tankage	To minimize emulsifier carryover to API separator
___	Segregate and dispose of ballast water to salt water channel, if available	To minimize brine contamination of treated water for reuse
___	Replace desalting with an aggressive chemical treatment system for applicable situation, through crude oil dehydration in tankage with emulsion breaker, chloride reduction with caustic injection, ammonia replacement with neutralizing amine, film inhibitor feed rate optimization and anti-foulant injection to debutanizer heat exchanger (Oil & Gas Journal, 3/20/1989, pg. 60)	To eliminate desalter water blowdown, which could be high in benzene and emulsifiers, while maintaining corrosion protection
___	Segregate and discharge blowdown and water treatment regenerant to salt water channel or truck to ocean outlet, if available	To minimize brine contamination of treated water for reuse

___	Use corrosion resistant liners in storage and slop oil tanks	To minimize sludge formation and need for tank cleaning
___	Install agitator in crude oil storage tanks	To minimize sludge accumulation
___	Avoid high shear pumping of oily wastes; use Archimedean screw pumps as appropriate	To minimize emulsion formation
___	Install tank cover and seal	To minimize emission loss and moisture entry
___	Install improved non-leaking seals	To eliminate leak losses
___	Install sealless pump	To eliminate leaks and fugitive emissions
___	Maintain seals regularly	To prevent leaks
___	Recycle seal flushes and purges	To minimize wastes for treatment
___	Pave process area	To minimize dirt entry to sewer
___	Install cover for sewer drain	To minimize dirt entry to sewer
___	Collect catalytic fines during loading and unloading	To prevent fines from becoming wastes
___	Recover coke fines for sale with coke	To prevent solids entry to sewer
___	Reuse recycled water for washdown if quality is desirable	To minimize need for discharge
___	Integrate process units to pass processing streams from one unit to the next, if appropriate	To avoid intermediate tankage but may lose operational flexibility
___	Blend fuels in-line	To avoid blending tankage
___	Install closed looped sampling system	To flush materials back to the tank or pipeline and minimize volatile compound emissions
___	Use computer software to track all hazardous materials and wastes	To better manage virgin materials and waste streams
___	Return oily wastewater and sludge from distribution and sales terminals to refinery as permitted by federal and state recycling regulations	To afford proper handling of oily wastes
___	Segregate scrap metals for sale	To reclaim metals for reuse

___	Recondition valve and vessel for reuse	To further reduce scrap metal wastes
___	Recover and reuse sandblasting grit as blasting media or as a light aggregate in concrete product	To minimize need for grit disposal, but beware of lead and heavy metal contaminations

Stormwater Management

___	Selectively cover loading rack and process areas to divert rainwater	To preclude rainwater contamination
___	Segregate storm water collection system from process drainage	To prevent cross contamination of storm water
___	Impound rainwater in collection basin or tank as appropriate	To hold water pending determination of treatment need
___	Sweep streets and redesign catch basins to exclude dirt	To prevent dirt entry to storm drain
___	Keep tank farm and process area clean, including secondary containment areas	To avoid contaminating rainwater
___	Reuse rainwater after gravity recovery of oil and solids	To minimize need for discharge
___	Discharge rainwater to public storm drain system under NPDES permit	To avoid using sewer capacity
___	Dike process area that drains to storm water collection system as appropriate	To prevent contamination of storm water
___	Regularly clean out drainage system to remove accumulated dirt	To minimize contamination of storm water

Firefighting Water and Spillage Management

___	Install tank overfill prevention system	To prevent spills
___	Pave areas under pipe rack	To facilitate leak detection
___	Contain spillage with diking and absorbent materials	To minimize spreading of spillage
___	Recover and reuse spillage	To minimize need for disposal
___	Impound fire fighting water in rainwater basins or storage tanks as appropriate	To hold and test before discharge or reuse
___	Prevent automatic crossover of storm drain to wastewater collection system	To prevent spills and fire fighting water that entered the storm drain system from overwhelming the wastewater treatment system

<u>Groundwater and Contaminated Soil Clean-up</u>

___	Recover floatable oil for reuse	To recover oil at source and avoid entrainment in transport
___	Pretreat and reinject treated groundwater if appropriate	To eliminate need for discharge to sewer
___	Reuse hydrocarbon contaminated soil as filler in asphalt paving manufacture	To avoid need for disposal
___	Reuse soil with mineral contents similar to shale as raw material substitute for cement kiln; reuse in pre-heater and calciner kiln is preferred, to maximize volatile hydrocarbon destruction	To avoid need for disposal

II. Production Process Modifications

<u>Separation Process</u>

___	Improve separation in distillation column through various means including the followings: . Increase the reflux ratio, . Add a new section to the column, . Match feed condition with the right feed tray, . Preheat column feed, . Install reusable insulation to prevent heat loss and fluctuation of column condition with weather.	To increase yield, and the separation of volatiles, e.g. benzene
___	Lower the reboiler temperature in distillation column through various means including the followings: . Retray column to lower pressure drop, . Increase size of vapor line to reduce pressure drop, . Use lower pressure steam or desuperheated steam, . Install a thermocompressor, . Lower column pressure.	To minimize degradation and and waste generation from high reboiler temperature
___	Improve overhead condensers to capture overhead losses	To minimize flaring and emissions

Conversion and Upgrading Processes

___	Improve conversion in reactors through various means including the followings: . Distribute feeds better at inlets and outlets, . Upgrade catalysts continuously, . Provide separate reactor for recycled streams for more ideal reactor conditions, . Better heating and cooling to avoid hot spots, . Improve control to maintain optimum conditions in reactor, . Use inhibitors to minimize unwanted side reactions.	To improve yield and conversion, and minimize the formation of undesirable compounds from side reactions
___	Filter catalyst fines from decanter oil from the Fluid Catalytic Cracking unit	To recover and reuse catalyst
___	Reclaim hydroprocessing catalysts for metals and alumina	To recover the metals on the catalysts like cobalt and molybdenum, as well as those removed from oil like nickel and vanadium; the alumina carrier is also recovered
___	Recycle catalyst for bauxite in cement manufacturing	To minimize need for disposal
___	Recover fluoride from spent caustics from a HF alkylation process by calcium precipitation	To produce calcium fluoride solids for use in cement industry or as fluxing agent in glass and steel industries
___	Reuse spent fluidized catalytic cracking unit (FCCU) catalysts in residue FCCU	To reuse catalysts in another FCCU where higher metal content on the catalysts can be tolerated
___	Reactivate catalysts for reuse	To reuse catalysts after the nickel and vanadium deposits are removed
___	Regenerate spent sulfuric acid by commercial reclaimer using incineration	To regenerate the acid and avoid neutralization
___	Reclaim extraction solvents like sulfolane and sulfinol	To recover solvents for reuse, with the residuals going for feed to a sulfuric acid plant because of their high BTU and sulfur contents

Product Treatment

___	Minimize the amount of caustic and rinse water used for product treatment through better contacting and recycling	To minimize need for treatment of wastewater
___	Consider hydrotreating for pollutant removal	To eliminate the use of caustic and water in product treatment
___	Send spent caustics to reclaimer	To reclaim cresylic and naphthenic compounds for sale
___	Reuse spent sulfuric caustics for paper manufacturing	To reuse the caustics if the strength is high enough
___	Regenerate clay from jet fuel filtration by washing with naphtha and drying by steam heating and feeding to furnace	To recycle filter clay

Equipment Cleaning - Heat Exchangers

___	Use lower pressure steam	To reduce tube-wall temperature and sludge formation
___	Desuperheat steam	To reduce tube-wall temperature and increase the effective surface area of the exchanger because the heat transfer coefficient of condensing steam is ten times greater than that of superheated steam
___	Install a thermocompressor	To reduce tube-wall temperature by combining high and low pressure steam
___	Use staged heating	To minimize degradation, staged heating can be accomplished first using waste heat, then low pressure steam and finally, desuperheated high pressure steam
___	Use on-line cleaning techniques for exchangers	Recirculating sponge balls and reversing brushes can be used to reduce exchanger maintenance and also to keep the tube surface clean so that lower temperature heat sources can be used
___	Use non-corroding tube	Corroded tube surfaces foul more quickly than non-corroded ones

Waste Gas Treatment

___	Regenerate di-ethanol-amine (DEA) using slip stream filtration in addition to carbon filtration	To remove degradation products and prolong DEA life
___	Substitute Sulften Sulfur Recovery Process for Beavon Process	To avoid generation of spent Stretford Solution which contains vanadium
___	Regenerate activated carbon from gas scrubbing	To avoid need for disposal

Wastewater and Sludge Treatment

___	Add forebay skimming for API separator	To recover more hydrocarbons for recycle
___	Use floating roof on treatemnt tanks and drains	To minimize air emissions
___	Use pressurized air in flotation	To minimize air emissions
___	Pretreat desalter water blowdown before co-mingling with other oily wastes, using absorption with light oil, or stripping with steam, nitrogen, methane or vacuum	To pretreat the high concentration of benzene and possibly, emulsifiers in the desalter water blowdown
___	Thicken sludge in sludge tank and decant supernatant	To aid in sludge dewatering
___	Treat sludge with heat and chemicals to release more oil and water	To further reduce hydrocarbon content in sludge
___	Dewater sludge to cake form	To minimize water content and remove some oil
___	Reclaim hydrocarbons in sludge by feeding it to a delayed coker which produces fuel grade coke	To dispose of solids and to reclaim hydrocarbon value
___	Use solvent extraction to remove hydrocarbons from sludge	To treat sludge for disposal and recover hydrocarbons
___	Use high temperature sludge drying to desorb hydrocarbons	To treat sludge for disposal and recover hydrocarbons
___	Feed sludge cake to cement kiln for energy recovery	To recyle sludge for its energy value
___	Evaluate gasification of oily wastes	To convert waste to usable methane

Utility Production - Steam, Hydrogen

___	Use closed-loop cooling water system	To minimize water loss
___	Demineralize cooling tower feed water	To reduce cleaning and waste generation
___	Use polymers for boiler feed water treatment	To reduce boiler cleaning
___	Collect condensate for reuse	To avoid sewer discharge
___	Use non-chromate corrosion inhibitor	To minimize chromate emissions and also chromate treatment in blowdown
___	Reclaim hydrogen plant catalysts	To recover materials in catalysts

III. Product Reformulation and Material Substitution

___	Reformulate leaded gasoline to non-leaded alternative with MTBE	To eliminate lead from gasoline and product storage tanks
___	Reduce benzene and other volatile hydrocarbons in gasoline through re-blending with oxygenates like MTBE	To decrease emissions of air toxics and smog-forming volatile organics